

The Novel Coronavirus Disease-COVID-19: Pandemic and Its Impact on Environment

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Authors' contributions

"This work was carried out in collaboration among all authors. Author MG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SK and SG managed the analyses of the study. Authors RKS and RSK managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2020/v39i1730748

Editor(s):

(1) Dr. Yahya Elshimali, Charles Drew University of Medicine and Science, USA.

Reviewers:

(1) Shuaishuai Hu, University of California, USA.

(2) Suphi Aydin, Afyonkarahisar Health Sciences University, Turkey.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/58239>

Review Article

Received 03 June 2020

Accepted 19 June 2020

Published 27 June 2020

ABSTRACT

The global disturbance caused by the COVID-19 pandemic has resulted in a number of effects and impacts on human beings and environment. The widespread coronavirus has caused diminishment worldwide in human lives and financial movement, inspite of the fact that typically major cause for concern, the inclining down of human movement and intervention shows a positive effect on the environment and climate. Industrial and transport outflows effluents have decreased measurable data bolsters the clearing of toxins and contamination in the air, soil and water. This impact is additionally in differentiate to carbon outflows, which was shot up by 5 percent after the worldwide financial related crash over a decade prior. As a result of boost investing on fossil fuels utilize to kick begin the worldwide economy. Water bodies have too been clearing and the Yamuna and Ganga as well as other rivers have seen critical advancement since the authorization of across and complete

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nationwide lockdown from 23rd March to 3rd June, 2020 as well as partial lockdown thereafter. Concurring to the real-time water observing information the normal water quality of 27 focuses of the Ganga seen in later days is reasonable for washing and proliferation of natural life and fisheries. Apart human lives, it has also been discussed that how to save our nature and environment by lockdown habit and guidelines need to be issued by Central Pollution Control Board disposed of precautionary material like gloves, mask, sanitizers and biomedical waste of medical health centers and quarantine centers.

Keywords: Corona virus; COVID-19; environment; climate; wildlife; pollution; pandemic.

1. INTRODUCTION

Coronaviruses may be a major gather of infections generally influencing human creatures through zoonotic transmission. In late December 2019, a cluster of cases with pneumonia of unidentified an etiology was reported in Wuhan city, Hubei province of People's Republic of China. This was soon identified to be caused by a novel strain of coronavirus, which was named as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1] and the disease caused by it as the coronavirus disease (COVID-19) [2]. Since then, an epidemic of acute respiratory tract infection has been set in swing with the rapid transmission of infections primarily spread over 54 countries, infected more than 85,403 individuals and resulted approximate 2,924 deaths [3], across the world. The pandemic virus has spread terribly and infected 90, 51,889 individuals reported 4, 70,821 deaths worldwide. According to Aarogya Setu App Virus is very rapidly spreading in India also @ 10,000 to 15,000 per day and infected 4,25,282 people and reported 13,699 deaths till 21st June, 2020. The exponential rise in the number of cases being witnessed daily has compelled the World Health Organization (WHO) to title this outbreak a pandemic [4].

Novel coronavirus disease-COVID-19 has transmitted to more than 213 nations across continents like Africa, America, Europe, South East Asia and Western Pacific. The World Health Organization had pronounced COVID-19 as the worldwide open wellbeing crisis and hence as global widespread disease around the world. It is presently one of the top-priority pathogens to be managed with all possibility, extreme ailment, mitigate mortality, need immediate control measures to check wide topographical spread [1].

History of COVID-19 pandemics: Covid-19 Pandemics of various infectious diseases with

millions of casualties have been recorded in the history for the past several centuries. The most well known in the history have been pandemic due to plague, in Asia and several pandemics of influenza that killed millions of people [5]. The pandemics continued in the current millennium too and COVID-19 is the latest and certainly not the last pandemic. One of the reasons for the occurrence and delayed response to pandemics is the lackluster approach in building capacity to respond to infectious diseases. With the availability of antibiotics, even the Surgeon General of the United States of America, William Stewart, said in 1967, "The time has come to shut the book on irresistible infections" [6]. But it was not to be. The past three decades have seen emergence of almost 40 new pathogens, most of which are viruses including HIV, hepatitis C virus and coronaviruses that have caused pandemics, novel-influenza viruses, etc [7]. Many non-technical but popular publications have also highlighted the persistence and revival of infectious diseases [8].

2. CORONAVIRUS GENOME STRUCTURE AND LIFE CYCLE

COVID-19 may be a spherical or pleomorphic encompassed particle containing single-stranded (positive-sense) RNA related with a nucleoprotein inside a capsid comprised of network protein. The envelope bears club-shaped glycoprotein projections. Some corona viruses also contain a hem agglutinin-esterase protein (HE) [9] (Fig. 1). Coronaviruses possess the largest genomes (26.4e31.7 kb) among all known RNA viruses, with G + C contents varying from 32% to 43%. Variable numbers of small ORFs are present between the various conserved genes (ORF1ab, spike, envelope, membrane and nucleo-capsid) and, downstream to the nucleo-capsid gene indifferent coronavirus lineages. The viral genome contains distinctive features, including a unique N-terminal fragment within the spike protein. Genes for the major

structural proteins in all coronaviruses occur in the 5'-3' order as S, E, M and N [10] (Fig. 2).

A commonplace Corona Virus contains a minimum six ORFs in its genome. Except for Gamma coronavirus that lacks nsp1, the first ORFs (ORF1a/b), about two-thirds of the whole genome length, encode 16 NSPs (nsp1-16). ORF1a and ORF1b contain a frame shift in between which produces two polypeptides pp1a and pp1ab. These polypeptides are processed by virally encoded chymotrypsin-like protease (3CLpro) or main protease (Mpro) and one or two papain-like proteases into 16nsps. All the auxiliary and extra proteins are interpreted from the sgRNAs of Corona Viruses. Four primary basic proteins contain spike (S), film (M), envelope (E), and nucleo-capsid (N) proteins are encoded by ORFs 10, 11 on the one-third of the genome close the 30-terminus [11,12]. Besides these four main structural proteins, different Corona Viruses encode special structural and accessory proteins, such as HE protein, 3a/b protein, and 4a/b protein. These mature proteins are responsible for several important functions in genome maintenance and virus replication [11].

There are three or four viral proteins in the corona virus membrane. The most abundant structural protein is the membrane (M) glycoprotein; it spans the membrane bilayer three times, leaving a short NH₂-terminal domain outside the virus and a long COOH terminus (cytoplasmic domain) inside the virion [9]. The

spike protein (S) as a type I membrane glycoprotein constitutes the peplomers. In fact, the main inducer of neutralizing antibodies is S protein. Between the envelope proteins with exist a molecular interaction that probably determines the formation and composition of the coronaviral membrane. M plays a predominant role in the intracellular formation of virus particles without requiring S. In the presence of tunicamycin coronavirus grows and produces spike less, noninfectious virions that contain M but devoid of S [9,10].

In Comparison of SARS-CoV2 (COVID-19), SARS-CoV, and MERS-CoV, The 5'UTR and 3'UTR are involved in inter and intramolecular interactions and are functionally important for RNA-RNA interactions and for binding of viral and cellular proteins [13]. At 5' end, Pb1ab is the first ORF of the whole genome length encoding non-structural proteins with size of 29844bp (7096aa), 29751bp (7073aa) and 30119bp (7078) in COVID-19, SARS-CoV; and MERS-CoV, respectively. Even with comparison of the spike protein at 3'end, among the coronaviruses specifically these three beta-coronaviruses, the difference was visualized, 1273aa, 21493aa and 1270aa in COVID-19, SARS-CoV, and MERS-CoV, respectively. Genetically, COVID-19 was less similar to SARS-CoV (about 79%) and MERS-CoV (about 50%). The arrangement of nucleocapsid protein (N), envelope protein (E), and membrane protein (M) among beta coronaviruses are different as depicted [14].

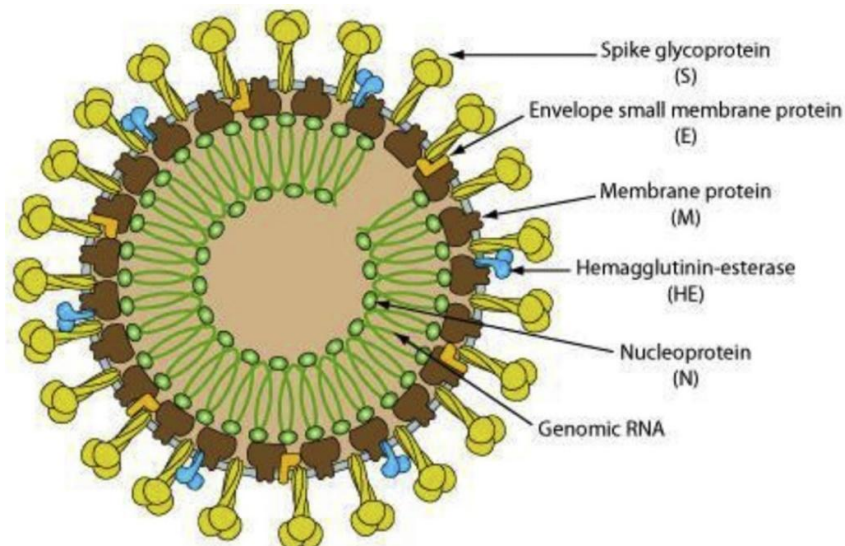


Fig. 1. Schematic of a coronavirus. This new virus probably looks a lot like this

Bio-wiki(<http://ruleof6ix.fieldofscience.com/2012/09>)

3. COVID-19 IMPACT ON ENVIRONMENT

The COVID-19 widespread has caused mechanical action to close down and cancelled flights, trains and other transport ventures, cutting nursery gas outflows and reduces contamination around the world. In this terrible situation, if something is positive to take from this difficult period, it might be that a taste of fresh air, we can breathe in less-carbon and other pollutants, cleaning soil and water as well as receiving timely rains etc.

3.1 Impact on Air Pollution

The WHO a World Wellbeing Association observed that about 3 million individuals passes each year [15] from sicknesses caused by air contamination, out of which more than 80% of individuals living in cities and urban areas usually more exposed to contaminated air levels that exceed secure limits [16]. The circumstances are more regrettable in poor nations, where 98% of cities and urban areas are not meeting the air quality standard as per specifications made by World Health Organization.

The European Space Agency's Sentinel measurements reported that amid late January

and early February 2020, levels of nitrogen dioxide (NO_2) over cities and mechanical zones in Asia and Europe were lower than within the same period in 2019, by as much as 40%. Most NO_2 comes from road transport and industrial plants and it can exacerbate respiratory illnesses such as asthma, bronchitis etc. It also makes symptoms worse for those suffering from lung or heart diseases.

After two weeks across the nation lockdown was reported on March 23 within the UK, NO_2 contamination in a few cities fell by as much as 60% compared to the same period in 2019 [17]. NASA uncovered that NO_2 contamination over New York and other major regions in north-east USA was 30% lower in March 2020 [18], compared to the monthly mean average from the year 2015 to 2019.

Major part of NO_2 releases from transport and industrial plants, it can worsen respiratory diseases such as asthma, bronchitis, nose and mouth infections. Besides, it may make patients more serious having lung or heart diseases. NO_2 outflows have been a especially prickly issue for Europe with numerous nations in breach of EU limits [19].

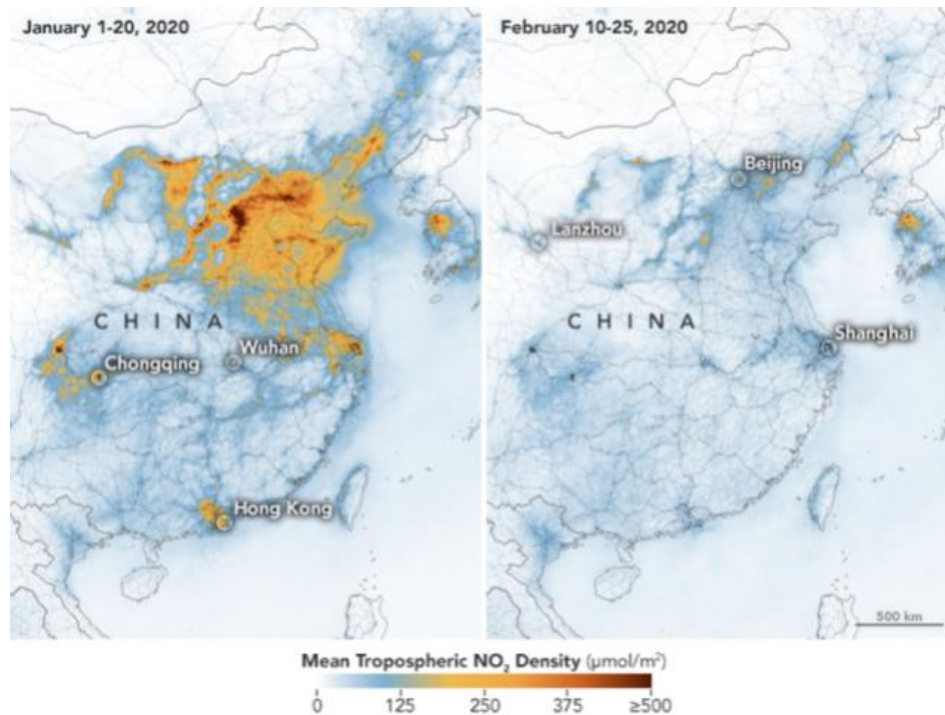


Fig. 2. As new daily cases of COVID-19 reached their peak in China, air pollution plummeted
ESA/NASA

3.2 Impact on Water Ways and Aquatic Life

In case of water and oceanic life, the water within the canals cleared and experienced more noteworthy water stream and availability of fish [20]. The Venice mayor's office clarified that the increment in water clarity was due to the settling of silt that's aggravated by water ways activities and said to diminish contamination along the waterways [21].

Request for angle and angle costs have both diminished due to the pandemic, [22] and angling armadas around the world sit for the most part idle [23]. Rainer Froese has said the angle biomass will increment due to the sharp decrease in angling, and anticipated that in European waters, a few angle such as herring may twofold their biomass [24]. As of April 2020, signs of sea-going recuperation stay generally anecdotal [25].

In India Water of river Ganga and other rivers has been found fit enough for bathing purposes and drinking to animals after decades, revealed "Since the lockdown, anthropological activities including disposal of industrial waste, socio-religious activities, waterways transport, fishing etc. were completely stopped in the vicinity of river. Due to lockdown, 22 drains which disposed of sewage into the Ganga river have been sealed tool making Ganga water cleaner.

Researchers and specialists revealed that water of the stream Ganga from Devprayag to Harki Paudi falls beneath 'A' category characterized by Central Contamination Control Board. This implies that water is fit for drinking."

This shown that there's no microscopic organisms in terms of MPN/100ml, which recognizes the number of microbes commonly alluded to as fecal coliform, which is a pointer for defilement. Too biochemical oxygen level fell underneath 3mg/Liters, which is a marker of good quality water, whereas a tall Biological Oxygen Demand (BOD) shows contaminated water.

3.3 Impact on Forest and Agroforestry

According to World Natural life Finance, woodlands cover more than 30% of the Earth's surface. The unstoppable growths in human population lead to deforestation for resources, industries and land for agriculture or grazing. Rising average temperature and ocean levels, and increased rate of extreme weather events affect not only the global land and ecosystem but also human health [26]. Deforestations are also linked to different types of disease due to the birds, bat-borne viral outbreaks [27-28]. Remember COVID-19 is bat related pandemic. To prevent this outbreak, billions of dollars are being spent to developing diagnostic treatment and medicine. But we are neglecting the primary

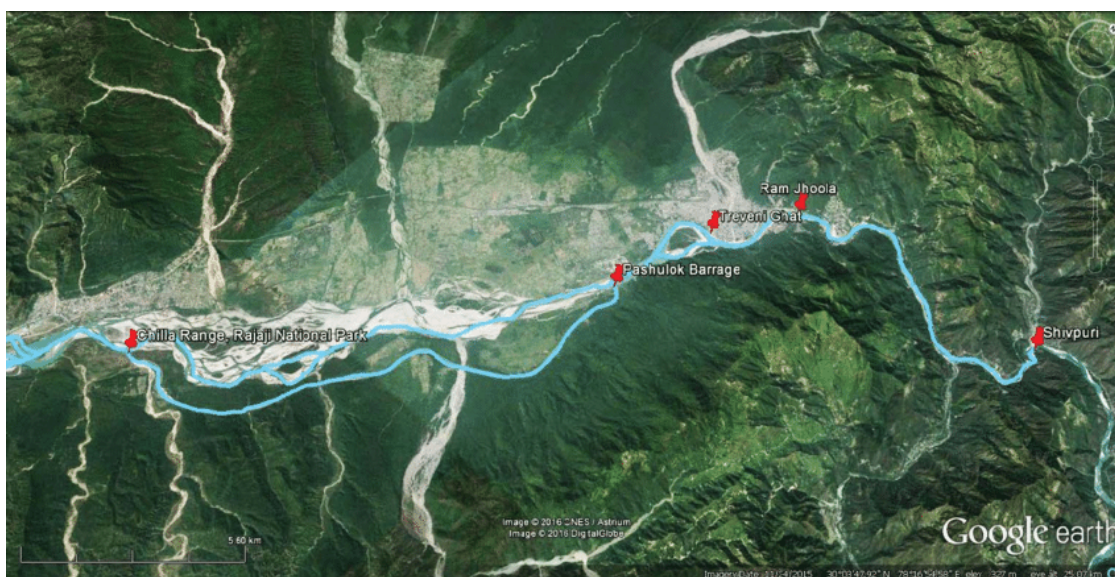


Fig. 3. Sampling sites in the stretch of Ganga river
Research gate

tools of prevention such as forestation and respecting wildlife habitats. During lockdown period forest recovered and become dense to some extent. So the wild animal not walking here and there as well as decreases the chances of infection also, animal hunting rate has gone down, therefore, animal are not being used consumption as a food source.

In other hand nature recovered the density of forest, fulfill the bad impact of deforestation, animal got their habitat inside the forest and they again maintain the environment, low rate of elephant death and also decreases the accident due to elephant and other animal attack in rural areas.

Due to recovery of forest, agroforestry could contribute to food security, social wealth and climate change, alleviation requires a clear understanding of the components and processes that are relevant for sustainable management of benefit flows from ecosystem services in changing agricultural landscapes. Agroforestry is often considered a cost-effective strategy for climate change mitigation. Tree-based farming systems store carbon in soils and woody biomass, and they may also reduce greenhouse gas emissions from soils [29-30]. The substantial carbon sequestration potential of agroforestry stems not so much from a high carbon density, but from the large areas that are potentially suitable for agroforestry, including many degraded areas [30]. Agroforestry has real potential to contribute to food security, climate change mitigation and adaptation.

3.4 Impact on Ecosystem

From the starting point of civilization, human beings gradually started manipulating the nature for its own benefit. In order to satisfy the demand of increasing population industrialization and urbanization became inevitable and the obvious significance was proved to be detrimental on the global environment. Further, environmental concerns include air pollution, water pollution, climate change, ozone layer depletion, global warming, depletion of ground water level, change of biodiversity & ecosystem, arsenic contamination and many more [31,32]. Global warming is a result of the increasing concentration of greenhouse gases (CO₂, CH₄, N₂O etc.). Out of the desire to drive the nature as per their own whims and desire, human beings started destroying the nature in numerous ways.

As an inevitable consequence environment pollution has become a big issue of the present day. But, due to the unusual outbreak of COVID-19, almost every big and small cities and villages in the affected countries like China, Taiwan, Italy, USA, France, Spain, Turkey, Iran, Germany, S Korea, U.K, India, Australia and many more are under partial of total lockdown for a long period of time ranging from a few weeks up to a few months.

All neighborhood and central organizations around the world have actually put a boycott on free development of their citizens exterior their domestic in arrange to dodge community transmission. The various religious, cultural, social, scientific, sport, and political mass gathering events like, Hajj, Olympics, satsang, political rallies, prayers gathering in temple, masjid etcare cancelled and shopping malls, school, colleges and universities are closed. Various types of industries are not functioning; all types of travels are cancelled. Meanwhile, efforts to restrict transmission of the SARS-CoV-2 by restricting the movement have had an outstanding environmental effect.

Due to non-functioning of industries, industrial waste emission has decreased to a large extent. Vehicles are hardly found on the roads resulting almost zero emission of green-house gases and toxic tiny suspended particles to the environment. Due to lesser demand of power in industries, use of fossil fuels or conventional energy sources have been lowered considerably. Ecosystems are being greatly recovered. In many big cities the inhabitants are experiencing a clear sky for the first time in their lives. The pollution level in tourist spots such as forests, sea beaches, hill areas etcare also shrinking largely. Ozone layer has been found to have revived to some extent. The pandemic has displayed its contrasting consequence on human civilization, in the sense that, on one hand it has executed worldwide destruction, but created a very positive impact on the world environment on the other hand.

The beginning point of COVID-19 flare-up was Hunan fish showcase, Wuhan, China. China has transitory put a boycott on natural life markets where creatures such as civet, bat, wolf pup, pangolin etc. are kept lively in little cages whereas on deal. 60% of emerging transferable diseases originate from animals and 70% of these are supposed to originate in wild animals. So, the unrestricted wildlife trade might enhance the risks of emerging new viruses. Many

scientists have urged different countries to permanently ban the wildlife markets and trades. These actions would help to protect human lives from future pandemics like COVID-19. Therefore, considering the national security, biosafety, and public health, it is essential to globally ban wildlife markets and trades.

3.5 Impact on Climate

The COVID-19 widespread is wreaking ruin in nations over the globe, causing a worldwide wellbeing emergency and constraining economies to moderate down due to the strict isolate measures. Be that as it may, the flare-up has too affected the environment in a charming way. As the widespread totally different parts of the world, its results run more distant than closed borders, rare hand sanitizer, and social separating conventions.

COVID-19 is killing millions of individuals; however, environmental protection is observed due to lesser intervention of human beings. The CO₂ outflows and human portability have been decreased, which makes strides discuss quality and energizes wild creatures to come out and investigate the cities.

Executive of the Worldwide Vitality Center clarified within the Atlantic Committee that the financial subsidence connected by the infection is likely to cause a drop within the carbon dioxide outflows for this year. He shown that NASA's partisan pictures have proven the contamination diminishment in China right after the carbon outflows had dropped by 25% in four weeks of lockdown.

The COVID-19 widespread will offer lessons and openings driving to natural activity in the long term. The danger of COVID-19 is for short period, in the meantime, danger of dry seasons, surges and extraordinary storms connected to climate alter will stay for a long time and will require steady activity. In truth, human creatures are portion of nature and all action that impacts the environment too impacts human being also.

In China, two months of diminished contamination has spared the lives of 4000 children beneath the age of 5 and 73000 people over the age of 70. Probably, this cannot be reason of whether the infection is good or bad for the climate, but in case able to make a useful financial framework that underpins individuals without undermining the life of Earth [33].

It is secure to say that no one needed carbon outflows to be decreased this way. COVID-19 contains a dull taken a toll to our lives, healthcare frameworks, and mental wellbeing of individuals around the world. All things considered, it has moreover appeared that communities can make a contrast when they pay attention of each other, and this may be a priceless lesson when we confront climate alter.

During lockdown we have seen weather is clear no pollution, no air contamination, raining time to time, monsoon has reached timely, environment is cool and healthy, it seems that time drought condition will not come and global warming will be reduced, COVID-19 brings health crisis whereas reduction of human intervention with environment is becoming beneficial for climate.

4. CONCLUSION

Here takeaway from this can be concluded that once countries come to grasps with the coronavirus, way better execution of the natural, transport and industry directions ought to be considered a need to ease the negative impacts of human activity on the environment. The universal community, because it battles to recapture an acknowledged typical, need to take into thought, the illuminating comes about of this widespread. The environment, for one, bounced back quicker than we thought it seem. And this bring in habit such type of lockdown need to be continued for thirty days every year for environmental protection as well as for our health and conservation of nature.

Other hand there is good impact on environment whereas bad impact on human health risk today's big issue is that how hazardous waste is being tackled. Medical waste generated during COVID-19 is not addressed by pollution control under environmental pollution controlling authorities. No any medical health centers and quarantine centers has biomedical waste bin and not collected by pollution control board. This is great risk for environment and human beings. So, there is need totake-up big step simultaneously to mitigate environmental pollution being created due tobiomedical waste of medical health centers and quarantine centers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Devendra T. Mourya, et al. Bio-risk assessment for infrastructure & biosafety requirements for the laboratories providing coronavirus. SARS-CoV-2/(COVID-19) Diagnosis; 2020.
2. World Health Organization. Novel coronavirus (2019-nCoV) situation report - 1. WHO; 2020. Available: <https://www.who.int/docs/default-source/coronavirus/situation-reports/2020-0121-sitrep-1-2019-ncov>, (Accessed on March 17, 2020)
3. World Health Organization. Coronavirus disease 2019 (COVID-19) situation report - 40. WHO; 2020. Available: <https://www.who.int/docs/default-source/coronavirus/situation-reports/20200229-sitrep-40-covid-19> (Accessed on March 17, 2020)
4. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19. WHO; 2020? Available: <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-mediabriefing-on-covid-19--11-march-2020> (Accessed on March 17, 2020)
5. Centers for Disease Control and Prevention, Pandemics influenza. Past pandemics. Atlanta: CDC; 2018. Available: <https://www.cdc.gov/flu/pandemic-resources/basics/past-pandemics.html>, (Accessed on February 23, 2020)
6. Wilson J. Bio threats - infectious diseases and national security. Available: <https://nationalsecurityforum.org/2017/02/14/3403/> (Accessed on February 29, 2020)
7. Bhatia R, Narain JP, Plianbangchang S. Emerging infectious diseases in East and South-East Asia. In: Detels.
8. Kan B, Wang M, Jing H, Xu H, Jiang X, Yan M, et al. Molecular evolution analysis and geographic investigation of severe acute respiratory syndrome coronavirus-like virus in palm civets at an animal market and on farms. *J Virol.* 2005;79(18):11892–900.
9. CAM deHaan, L Kuo, PS Masters, H Vennema, PJM Rottier Coronavirus particle assembly: Primary structure requirements of the membrane protein *J Virol.* 1998;72(8):6838-6850.
10. Woo PCY, Huang Y, Lau SKP, Yuen KY. Coronavirus genomics and bioinformatics analysis *Viruses.* 2010;2(8):1804-1820.
11. Czub M, Weingartl H, Czub S, He R, Cao J. Evaluation of modified vaccinia virus Ankara based recombinant SARS Vaccine in Ferrets. 2005;23(17–18):2273-2279.
12. Yang D, Leibowitz JL. The structure and functions of coronavirus genomic 3' and 5' ends, *Virus Res.* 2015;206:120-133.
13. Lu R, Zhao X, Li J, Niu P, Yang B, Wu, H et al. Genomic characterization and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding, *Lancet.* 2020;395(10224):565-574.
14. The contribution of outdoor air pollution sources to premature mortality on a global scale. J. Lelieveld, J. S. Evans, M. Fnais D. Giannadaki & A. Pozzer *Nature.* 2015; 525:367–371.
15. Ambient air pollution: A global assessment of exposure and burden of disease Authors: World Health Organization; 2016. [ISBN: 9789241511353]
16. Coronavirus lockdown sees air pollution plummet across UK By Anna Khoo BBC Shared Data Unit; 2020.
17. NASA Satellite Data Show 30 Percent Drop in Air Pollution Over Northeast U.S; 2020.
18. European Environment Agency Exceedances of air quality limit values due to traffic; 2019.
19. "Jellyfish seen swimming in Venice's canals". CNN; 2020. (Retrieved 25 April 2020)
20. Srikanth, Anagha (18 March 2020). As Italy quarantines over coronavirus, swans appear in Venice canals, dolphins swim up playfully. *The Hill.* Archived from the original; 2020. (Retrieved 20 March 2020)
21. Korten, Tristram (8 April 2020). "With Boats Stuck in Harbor Because of COVID-19, Will Fish Bounce Back?". *Smithsonian Magazine.* (Retrieved 24 April, 2020)
22. Reiley, Laura (8 April 2020). Commercial fishing industry in free fall as restaurants close, consumers hunker down and vessels tie up. *The Washington Post.* (Retrieved 25 April 2020)
23. Millan Lombrana, Laura (17 April 2020). With Fishing Fleets Tied Up, Marine

- Life Has a Chance to Recover. Bloomberg Green. (Retrieved 25 April 2020)
24. Water of river Ganga has been found fit enough for drinking purposes after decades, revealed a recent research by Indian Institute of Technology, Roorkee, Published; 2020.
 25. Ruscio BA, Brubaker M, Glasser J, Hueston W, Hennessy TW. One health – a strategy for resilience in a changing arctic. *Int. J. Circumpolar Health*. 2015;74. [Article 27913]
 26. Afelt A, Frutos R, Devaux C, Bats, coronaviruses and deforestation: Toward the emergence of novel infectious diseases? *Front. Microbiol*. 2018;9:702.
 27. J Olivero, JE Fa, R Real, et al. Recent loss of closed forests is associated with Ebola virus disease outbreaks *Sci. Rep*. 2017;7. [Article 14291]
 28. Smith P, Olesen JE. Synergies between the mitigation of, and adaptation to, climate change in agriculture *J Agric Sci*. 2010; 148:543-552.
 29. Verchot LV, Noordwijk MV, Kandji S, Tomich T, Ong C, Albrecht A, Mackensen J, Bantilan C, Anupama KV, Palm C. Climate change: linking adaptation and mitigation through agroforestry *Mitigation Adaptation Strategies Global Change*. 2007;12:901-918.
 30. Kandji ST, Verchot LV, Mackensen J, Boye A, Noordwijk Mv, Tomich TP, Ong C, Albrecht A, Palm C. Opportunities for Linking Climate Change Adaptation and Mitigation Through Agroforestry Systems *ICRAF*. 2006;9.
 31. Bremer S, Schneider P, Glavovic B. Climate change and amplified representations of natural hazards in institutional cultures *Oxford Res. Encycl. Nat. Hazard Sci*; 2019.
 32. Coutts A, Beringer J, Tapper N. Changing urban climate and CO2 emissions: Implications for the development of policies for sustainable cities *Urban Policy Res*. 2010;28:27-47.
 33. China's coronavirus lockdown curbs deadly pollution, likely saving the lives of tens of thousands, says researcher *By Ivana Kottasová, CNN Updated 1935 GMT (0335 HKT); 2020.*

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Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/58239>